Section II (Remarks)

A. Status of Claims

Claims 1-8 and 10-120 are pending in the application, with claims 52-120 being withdrawn from consideration. Claim 9 was cancelled previously.

B. Response to Claim Rejections Under 35 U.S.C. 103

In the February 12, 2007 Office Action, claims 1-8 and 10-51 were rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,806,508 to D'Evelyn (hereinafter, "D'Evelyn '508"). Such rejections are traversed for the reasons provided below.

1. Law Regarding Obviousness

Concerning §103 obviousness rejections, three requirements must be met for a *prima facie* case of obviousness. First, the **prior art reference(s) must teach all of the limitations of the claims**. MPEP § 2143.03. Second, there must be a motivation to modify the reference or combine the teachings to produce the claimed invention. MPEP § 2143.01. Third, a reasonable expectation of success is required. MPEP § 2143.02. In addition, the teaching or suggestion to combine and the expectation of success must both be found in the prior art and not based on applicant's disclosure. MPEP § 2143. A further consideration, which applies to all obviousness rejections, is that "[a] prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (F

The Federal Circuit has repeatedly cautioned that **prior art must be enabling to support an obviousness rejection**. As recently as 2005, the Federal Circuit stated:

> **Although published subject matter is "prior art" for all that it discloses, in order to render an invention unpatentable for obviousness, the prior art must enable a person of ordinary skill to make and use the invention.**[1] **Thus**

[1] *Citing Beckman Instruments Inc. v. LKB Produkter AB*, 892 F.2d 1547, 1551, 13 USPQ2d 1301, 1304 (Fed. Cir. 1989)(emphasis added). *See also Motorola, Inc. v. Interdigital Tech. Corp.*, 121 F.3d 1461, 1471, 43 USPQ2d 1481, 1489 (Fed. Cir. 1997)("In order to render a claimed apparatus or method obvious, the prior art must enable one skilled in the art to make and use the apparatus or method.") (quoting *Beckman*, 892 F.2d 1547, 1551, 13 USPQ2d 1301, 1304 (Fed. Cir. 1989)).

> **when a *prima facie* case of obviousness is deemed made based on similarity to a known composition or device, rebuttal may take the form of evidence that the prior art does not enable the claimed subject matter.[2] The applicant has the burden of coming forward with evidence in rebuttal, when the prior art includes a method that appears, on its face, to be capable of producing the claimed composition. This burden may be met by presenting sufficient reason or authority or evidence, on the facts of the case, to show that the prior art method would not produce or would not be expected to produce the claimed subject matter.**

In re Kumar, 418 F3d 1361, 76 USPQ2d 1048, 1052-53 (Fed. Cir. 2005).

2. Non-Enablement By D'Evelyn '408 of the Subject Matter of the Pending Claims

While D'Evelyn '508 may have *contemplated* "single gallium nitride crystals having a diameter and a thickness in a range from about 0.02 inch (about 0.05 cm) to about 12 inches (about 30 cm) and for example, a size in a range from about 2 inches to about 6 inches" (D'Evelyn '508, col. 4, lines 61-66), it is abundantly clear that D'Evelyn '508 has **NOT enabled** low dislocation density crystals over such a wide (e.g., *600-fold*, from 0.02 inch up to 12 inch diameter and thickness) range. Enclosed as evidence supporting this point is a Declaration of Dr. Robert P. Vaudo Under 37 CFR § 1.132 (hereinafter, the "Vaudo Decl.").

D'Evelyn '508 contemplates "single gallium nitride crystals having a diameter and a thickness in a range from about 0.02 inch (about 0.05 cm) to about 12 inches (about 30 cm) and for example, a size in a range from about 2 inches to about 6 inches" (D'Evelyn '508, col. 4, lines 61-66). This is an extremely wide range, i.e., representing a 600-fold span from the lowest value (e.g., 0.02 inch) to the highest value (e.g., 12 inches).

[2] *Citing In re Payne*, 606 F.2d 303, 314, 203 USPQ 245 (CCPA 1979)] ("the presumption of obviousness based on close structural similarity is overcome where the prior art does not disclose or render obvious a method for making the claimed compound")[emphasis added]; *In re Hoeksema*, 399 F.2d 269, 274 [158 USPQ 596] (CCPA 1968) ("the absence of a known or obvious process for making the claimed compounds overcomes a presumption that the compounds are obvious, based on close relationships between their structures and those of prior art compounds") [emphasis added].

D'Evelyn '508 purports to teach the fabrication of large area gallium nitride crystals via a "high pressure high temperature" process, with the following excerpt from D'Evelyn '508 representing the most detailed instructions for implementing such growth process:

> More specifically, one suitable process for forming the GaN substrate comprises providing a source gallium nitride, solvent, and mineralizer. The source gallium nitride may comprise at least one of poorly-crystallized gallium nitride, well-crystallized gallium nitride, amorphous gallium nitride, polycrystalline gallium nitride, and combinations thereof. The source gallium nitride may be provided "as-is" in its raw form. Alternatively, the source gallium nitride can be compacted into a "pill" or sintered into a polycrystalline compact. Alternatively, the source gallium nitride can be formed in situ by providing gallium metal which then reacts with the ammonia solvent after sealing of the capsule and treatment at high pressure and high temperature to form source gallium nitride.
>
> The source gallium nitride may then be combined with at least one of the mineralizer and solvent to form a mixture. The gallium nitride, solvent, and mineralizer may optionally be provided individually to the capsule as separate and distinct un-combined materials. The mixture, which can comprise gallium nitride and at least one of the solvent and mineralizer, can be optionally compacted into a pill, however the compacting of the mixture need not be conducted in the gallium nitride growth process.
>
> The source gallium nitride, solvent, and mineralizer are then placed inside a capsule as either a compacted or uncompacted mixture. Optionally, additional mineralizer can also be added to the capsule. The capsule, which will be described hereinafter, can then be filled with a nitrogen-containing solvent, for example at least one of ammonia or hydrazine, or an organic solvent, including but not limited to, methylamine, melamine, ethylene diamine, and mixtures thereof. The capsule is then sealed, disposed in a pressure cell, and subjected to high pressure and high temperature conditions in an appropriate high pressure high temperature (HPHT) system. The HPHT conditions are maintained for a length of time sufficient to dissolve the source gallium nitride and re-precipitate it onto at least one gallium nitride crystal, gallium nitride boule, or gallium nitride crystal seed.
>
> Maintaining HPHT conditions yields large single gallium nitride crystals, for example single gallium nitride crystals having a diameter and thickness in a range from about 0.02 inch (about 0.05 cm) to about 12 inches (about 30 cm) and, for example, a size in a range from about 2 inches to about 6 inches. The pressure, as embodied by the invention, is in a range from greater than about 5 kbar to about 80 kbar, and the temperature for the gallium nitride crystal growth process is in a range between about 550.degree. C. and about 3000.degree. C. The GaN single crystals thus formed are substantially transparent, with an absorption coefficient below 100 cm.sup.-1. Furthermore, the substrates of the present invention have carrier mobilities above about 100 cm.sup.2 /V-s and strain, with respect to undoped GaN homoepitaxial layers, below about 0.005%.

D'Evelyn '508, col. 4, line 22 – col. 5, line 8.

While D'Evelyn '508 purports to teach the fabrication of large area gallium nitride crystals and to further teach the fabrication of low defect density gallium nitride crystals, the disclosure of D'Evelyn '508 gives rise to many critical but unanswered questions regarding fabrication of gallium nitride crystals characterized simultaneously by both large area and low defect density. (Vaudo Decl., ¶ 6.) Such questions include:

(A) How is growth nucleated to replicate the seed and prevent inhomogeneity and cracking in the growing GaN crystal according to D'Evelyn's HPHT process?

(B) How are spurious deposits eliminated so that high quality growth can be carried out for the presumably many days and/or weeks needed to make large area crystals according to D'Evelyn's HPHT process?

(C) What measures are taken to eliminate the nucleation of polycrystalline growth or evolving growth conditions with growth of a large crystal according to D'Evelyn's HPHT process?

(D) How are during growth stresses managed to eliminate cracking, which would reduce the useful size of the resulting crystal grown according to D'Evelyn's HPHT process?

(Vaudo Decl., ¶ 6.)

One of ordinary skill in the art would require answers to the foregoing questions (A)-(D) in order to grow GaN crystals characterized *simultaneously* by large area and low defect density (*i.e.*, within the scope of the claims of the present U.S. Patent Application No. 10/712,351) using the high pressure high temperature process of D'Evelyn '508. (Vaudo Decl., ¶ 6.) Nothing in D'Evelyn '508, however, provides any answers or guidance relating to any of the foregoing four critical questions. (Id.)

To one of ordinary skill in the art, these gaps in the disclosure of D'Evelyn '508 compel the conclusion that D'Evelyn '508 fails to enable large area, low defect density GaN within the scope of the claims of the present U.S. Patent Application No. 10/712,351. (Vaudo Decl., ¶ 7.)

Generally speaking, at the time the present invention was made, it was not difficult for one skilled in the art to grow low dislocation density GaN crystals of small size, but it was many magnitudes more difficult to grow GaN crystals characterized by BOTH large area and low dislocation density. (Vaudo Decl., ¶ 8.)

D'Evelyn '508 specifically avoids any recitation of dislocation density achieved by the so-called 'high pressure high temperature' or "HPHT" process as applied to a GaN crystal of any particular size. (See D'Evelyn '508 & Vaudo Decl. ¶ 9.) Likewise, D'Evelyn '508 fails to claim low dislocation density GaN in conjunction with a crystal of any particular size. (Id.)

The lack of enablement of large area, low disclocation density GaN crystals by D'Evelyn '508 is consistent with D'Evelyn's 508's failure to claim such subject matter. D'Evelyn '508 includes claims directed solely to photodetectors, to the exclusion of any claims directed to large area, low dislocation density GaN crystals. (See D'Evelyn '508 & Vaudo Decl. ¶ 10.) It is immediately recognizable to one skilled in the art that the value of patent cover for large area, low dislocation density GaN crystals (which are susceptible to a variety of uses) would be many times greater than the relatively narrow photodetector claims provided in D'Evelyn '508. (Vaudo Decl. ¶ 10.) While the failure of D'Evelyn '508 to claim large area, low dislocation density GaN crystals is not dispositive on the issue of non-enablement, such failure is certainly consistent with non-enablement of the broader subject matter. (Id.)

Most damning to any claim of enablement, however, is publication by M.P. D'Evelyn (i.e., one and the same as the first named inventor in "D'Evelyn '508," in conjunction with other authors) of a paper entitled "Growth and Characterization of Bulk GaN Crystals at High Pressure and High Temperature" (Mat. Res. Soc. Symp. Proc. Vol. 798, Materials Research Society, 2004) (hereinafter, the "D'Evelyn Paper," already made of record in the instant application and further attached as Exhibit A to the Vaudo Declaration) in which Mr. D'Evelyn et al. admit that "[t]he largest [GaN] crystal we have grown to date is 15x18 mm in diameter" using a purported high temperature high pressure process. See D'Evelyn Paper at page 276, bottom paragraph. Moreover, in the final passage, D'Evelyn and his co-authors state their belief "that continued development of the present method will permit low-cost manufacturing of high-quality true bulk GaN boules and wafers larger than 50 mm in diameter."

Notably, the D'Evelyn Paper was published in 2004 – three years after the filing in 2001 of U.S. patent application 09/839,941 that matured into D'Evelyn '508. If Mr. D'Evelyn (as co-inventor of D'Evelyn '508) had truly enabled GaN crystals of up to **12 inch** diameter in 2001 using a high pressure high temperature process, it is bewildering – to say the least – that after three years of additional research, he was unable to produce single crystals of GaN greater than 18 mm (i.e., **under 1 inch**) diameter in 2004, again using a high pressure high temperature process. Likewise, if Mr. D'Evelyn had enabled 12 inch diameter GaN crystals in 2001, why would "continued development" be necessary in 2004 to support scalability of the high pressure high temperature process to produce GaN wafers larger than 50 mm (2.3 inches)? These facts further support the conclusion to one skilled in the art that D'Evelyn '508 failed to enable the fabrication of large area, low defect density GaN within the scope of the claims of the present U.S. Patent Application No. 10/712,351. (Vaudo Decl., ¶ 11.)

Furthermore, close examination of the D'Evelyn Paper reveals that the authors again took great care to list size and defect (e.g., dislocation) density characteristics of GaN crystals separately so that dislocations and area are not necessarily provided together for any single wafer. A hundred-fold (two order of magnitude) range of defect density, i.e., 10^6 to 10^8 cm^{-2}, was reported for etch pit density in the D'Evelyn Paper (with such a wide range suggesting process inconsistency), but without specific correlation of defect density to any particular wafers. (Vaudo Decl., ¶ 12.) Notably, the largest area wafer (D'Evelyn Paper, page 277, Fig. 4) was "dark" in appearance, which appearance is not consistent with low dislocation density (rather, low defect density GaN should be clear). (Vaudo Decl., ¶ 12.) These facts still further support the conclusion to one skilled in the art that D'Evelyn '508 failed to enable the fabrication of large area, low defect density GaN within the scope of the claims of the present U.S. Patent Application No. 10/712,351. (Vaudo Decl., ¶ 12.)

Based on all of the foregoing evidence, Applicants have clearly rebutted any presumption of enablement in D'Evelyn '508 of the subject matter of the pending claims, pursuant to *In re Kumar*, 418 F3d 1361, 76 USPQ2d 1048, 1052-53 (Fed. Cir. 2005). The claims of the present application (for example, claim 1) recite large area of at least 15 cm^2 and low dislocation density not exceeding 3×10^6 dislocations per cm^2 of growth surface area on the face. D'Evelyn '508 at best suggests a *goal of, or wish for,* 12 inch diameter GaN with low defect density, but fails to enable any method for yielding such product. In fact, the D'Evelyn Paper lacks answers to all of

the above-recited questions (A)-(D) that would be required by one skilled in the art in order to grow GaN crystals characterized *simultaneously* by large area and low defect density (*i.e.*, within the scope of the claims of the present U.S. Patent Application.

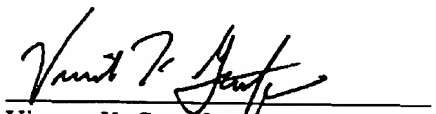
Since D'Evelyn is not enabled as to the subject matter of pending claims 1-8 and 10-51, the obviousness rejection of such claims cannot stand pursuant to applicable Federal Circuit precedent. Withdrawal of the obviousness rejections of claims 1-8 and 10-51 is warranted, and respectfully requested.

CONCLUSION

Based on the foregoing, all of applicants' pending claims 1-8 and 10-51 are patently distinguished over the art, and in form and condition for allowance. The examiner is requested to favorably consider the foregoing, and to responsively issue a Notice of Allowance. If, for some reason, the examiner is not inclined to allow claims 1-8 and 10-51 of the present application, then entry of the accompanying Vaudo Declaration into the record is requested to put the application in better form for appeal.

If any issues require further resolution, the examiner is requested to contact the undersigned attorney at (919) 419-9350 to discuss same.

Respectfully submitted,



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Enclosure:
Declaration of Dr. Robert P. Vaudo Under 37 CFR § 1.132 with Exhibit A [12 pgs.]

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